
PROF. DR. MARTIN STEINEBACH

OPEN THESIS TOPICS

Our research group is always interested in motivated students who want to do their Bachelor's or Master's thesis. In the following we provide open thesis topics we can currently offer.

In case you are interested in these thesis subjects – or have your own thesis proposals – please don't hesitate to contact us:

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WWW: <https://www.sit.fraunhofer.de/de/mediasecurity/>
<https://www.sit.fraunhofer.de/de/itforensics/>

Version 19.02.2025

OBJECT RECOGNITION THROUGH VISIBLE COLOR PATTERN

- Plug and Play solution for "discovering" offline objects in images and videos
- Develop a robust method that uses visible color patterns to make objects discoverable for digital devices (video, image).
- In the Thesis
 - $n \geq 4$ different color patterns are to be created, which can be robustly recognized by neural /deep learning
 - Post-processing (dewarping, rotation, etc.) of the recognized space enclosed by the color patterns for further use (OCR or similar)
 - A good starting point is for example



AUDIO DEEPPAKE GENERATION

- The quality of audio deepfakes is rapidly improving in conjunction with the advances in artificial intelligence. Audio deepfake generation methods can be classified into two main categories: voice conversion (VC) and text-to-speech synthesis (TTS).
- The goals of this thesis are:
 - To analyze state-of-the-art generation methods (VC and/or TTS) and to identify potential avenues for improvement.
 - To provide an implementation of a generation system that can enhance the quality of the generated audio recording and increase its similarity to the target speaker
- Earlier work regarding audio deepfake generation:
 - <https://www.mdpi.com/2076-3417/13/5/3100>
 - <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10096399>



AUDIO DEEPFAKE DETECTION

- As the amount of AI-generated audio content on social media rapidly increases, there is a growing necessity to develop detectors that can distinguish between AI-generated and genuine audio.
- The goals of this thesis are:
 - To analyze state-of-the-art detection methods and to identify potential avenues for improvement.
 - To provide an implementation of a classification system that can improve the results on e.g. the in-the-wild dataset
- Earlier work regarding audio deepfake detection:
 - <https://www.mdpi.com/1999-4893/15/5/155>
 - <https://dl.acm.org/doi/pdf/10.1145/3658664.3659662>



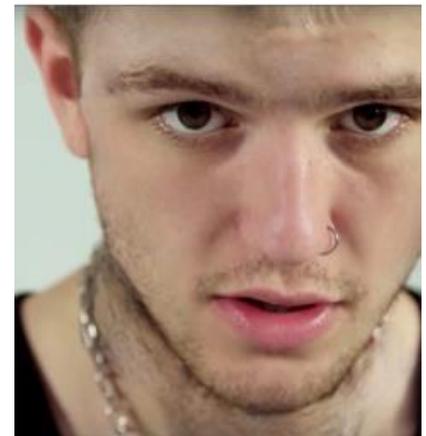
AI-GENERATED TEXT DETECTION

- As the amount of AI-generated content is rapidly increases, there is a growing necessity to develop detectors that can distinguish between AI-generated and genuine text.
- The goals of this thesis are:
 - To analyze state-of-the-art detection methods and to identify potential avenues for improvement.
 - To provide an implementation of a classification system that can improve the results on real-world datasets (e.g. DetectRL)
- Earlier work regarding AI-generated text detection:
 - <https://github.com/junchaoIU/DetectRL>
 - <https://aclanthology.org/2023.ranlp-stud.1.pdf>



DETECTING SYNTHETIC IMAGE CONTENT CREATED BY „INPAINTING“

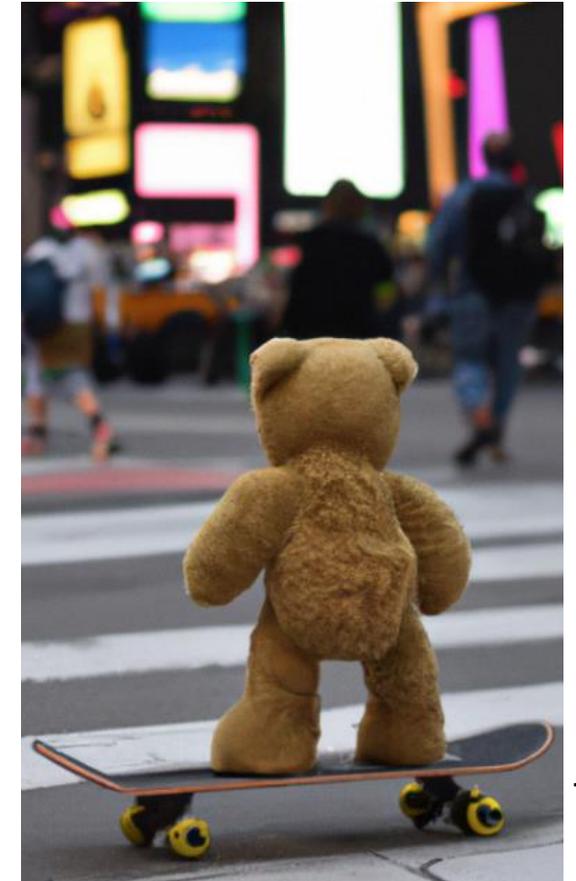
- Detail in digital images can be enhanced or created using ML-based image synthesis methods in terms of „inpainting“. Such enhancements can be applied for malicious purposes such as forging digital evidence or distributing fake news
- Current methods for identifying inpainting feature varying detection performance with respect to different image inpainting algorithms
- The goals of this thesis are:
 - To analyze the shortcomings of current detection algorithms for “inpainting”
 - To improve the forgery detection performance by exploiting common characteristics of a selection of synthesis algorithms
- Earlier work regarding the detection of splicing boundaries:
 - https://openaccess.thecvf.com/content_CVPR_2020/papers/Li_Face_X-Ray_for_More_General_Face_Forgery_Detection_CVPR_2020_paper.pdf



https://www.reddit.com/r/LiPeep/comments/f4c1uz/tattooless_peep_using_the_nvidia_image_inpainting/

DETECTING SYNTHETIC IMAGES CREATED BY „FULL IMAGE SYNTHESIS“

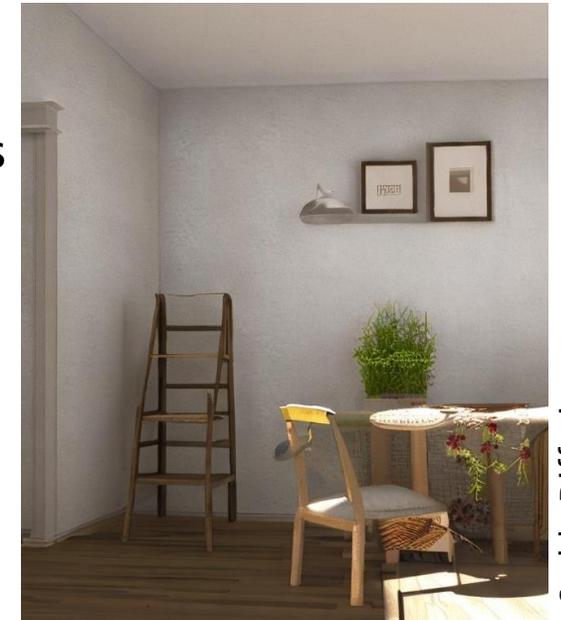
- Digital images can be created using ML-based image synthesis. In contrast to „inpainting“ *full* images can be synthesized from scratch in a photorealistic appearance. Such enhancements can be applied for malicious purposes such as making up digital evidence or fake news
- Current methods for “full image synthesis” identification feature varying detection performance with respect to different image synthesis algorithms
- The goals of this thesis are:
 - To analyze the shortcomings of current detection algorithms for “full image synthesis”
 - To implement a detection method exploiting characteristics of a selection of synthesis algorithms to improve the forgery detection performance
- Earlier works regarding the annotation of synthetically generated images:
 - <https://arxiv.org/pdf/2211.00680v1.pdf>



openai.com

RECOGNIZING ROOMS/LOCATIONS INSIDE BUILDINGS BASED ON REFERENCE DATA

- There exist several solutions for recognizing objects in images and videos as well as techniques to match visual data. For some use-cases training an ML-based solution is challenging as training data is scarce.
- Training an ML-based classifier on 3D synthesized data to estimate the facial landmarks of human faces has shown to outperform state-of-the-art methods
- The goals of this thesis are:
 - To analyze whether synthesizing training data in 3D space can improve the performance of methods trying to match the interior of a room
 - To evaluate the transferability on real data
- Requirements: Knowledge in 3D modelling and/or game engines
- Earlier works regarding the transfer of synthesized image data:
 - https://openaccess.thecvf.com/content/ICCV2021/papers/Wood_Fake_It_Till_You_Make_It_Face_Analysis_in_the_ICCV_2021_paper.pdf



Stable Diffusion

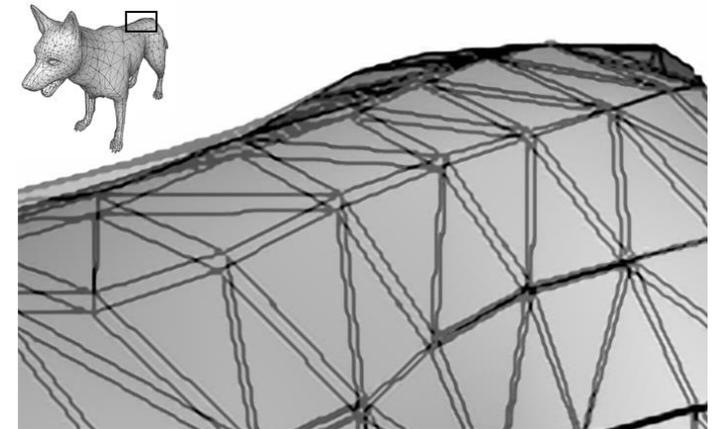
IMAGE MANIPULATION DETECTION

- Digital images are subject to manipulation. Powerful image editing tools make it possible to manipulate images without specialized skills. Therefore, image forensics is needed to verify the integrity and authenticity of digital images.
- Different types of manipulations leave different traces, which can not be easily detected by a single method. Moreover, such traces can be weakened or even eliminated by post-processing.
- The goal of this thesis is to
 - develop or improve a deep learning based or classical forensic algorithm for specific image manipulations
 - implement the forensic algorithm
 - evaluate the implemented algorithm using different datasets
- Related Work:
 - <https://www.sciencedirect.com/science/article/pii/S1051200417301938>



3D-MODEL WATERMARK

- Decentralized production becomes more important with 3D printers
- 3D models are sent to the printers and printed/manufactured on-site
- Sharing the print data, or scanning a 3D model and duplicating it, is possible and that is where this process fails to progress
- The goal of this thesis
 - Is to design a digital watermarking technique for 3D models with the following properties
 - Written for G Code
 - Watermark extractable after 3D printing and scanning
 - Watermark is imperceptible to a person
 - Implement the designed watermark and evaluate it
 - A good starting point is e.g. <https://arxiv.org/abs/2109.07202>



TOPIC MODELLING IN CHATS

- The analysis of topics within chat conversations facilitates a comprehensive understanding of the main discussion points and trends observed in communication. Topic modelling techniques can be used to improve customer service or detect criminal activity in chats.
- The characteristics of the language used in chats and the dynamic nature of the development of topics in chat conversations present a great challenge to topic identification in chats. The ability to accurately identify the main topic of a chat conversation depends on several factors, including the context awareness of the algorithm.
- Goal of the thesis:
 - Investigate the state of the art in topic modelling techniques
 - Discuss the robustness of their implementation in chat analysis
 - Develop a concept for topic analysis in chats
 - Implement and evaluate the proposed method
 - Relevant dataset: NPS Chat Corpus



THREAD DETECTION IN CHAT STREAMS

- Unlike written discourse such as reviews, comments or news articles, chat streams typically lack a linear discussion of a single topic. Instead, they comprise a multitude of partially threaded and interrelated topics presented in the form of shorter, incomplete messages that do not always follow a clear narrative thread.
- To gain a deeper comprehension of contextual relatedness among chat messages, the development of algorithms capable of tracking the dynamic nature of chat streams is essential.
- Goal of the thesis:
 - Research the topic and existing techniques
 - Develop a concept for identifying threads in chat streams
 - Implement and evaluate the proposed method
 - Relevant dataset: NPS Chat Corpus

Alice: Hey, did you see the game last night?

Bob: Yeah, it was incredible! I can't believe that final goal. By the way, did you finish the project report?

Alice: Almost. I was thinking, we should add some graphs to the report.

Bob: Good idea. I can work on the graphs. Did you get a chance to look at the new restaurant menu I sent you?

Alice: Yes, it looks great. We should try it out this weekend. And I'll finish my part of the report by tonight.

Bob: Awesome. The weekend sounds perfect. Don't forget to send me your part of the report.

Alice: Will do.

AUTHOR PROFILING IN CHAT LOGS

- Author profiling is the task of identifying demographic characteristics (e.g. gender, age, geographic origin, level of education, native language) or psychometric traits of the author of a text. It has a wide range of applications, including commercial, sociological or cybercrime contexts.
- The incomplete casual language used by interlocutors in chats presents a challenge for author profiling. However, it also offers opportunities for predicting author identity, such as geographic origin or educational level, due to the specific words used in chat conversations.
- Goal of the thesis:
 - Investigate and discuss the state of the art
 - Develop a concept for author profiling in chats
 - Implement and evaluate the proposed method
 - Relevant datasets: PAN Datasets, PJ Dataset



SEXUAL PREDATOR IDENTIFICATION IN CHATS

- Online sexual predation represents a significant social issue. The development of effective methods for identifying predators can have a profound impact on enhancing online safety, particularly for vulnerable underage groups.
- The objective of this thesis is to develop a system which enables
 - (1) the differentiation of sexual predators from victims engaged in online chat conversations, and
 - (2) the identification of the precise lines of the conversation which indicate a propensity for sexual exploitation of other chat participants.
- Available dataset: PAN 12



Source: WikiHow

IDENTIFYING IDENTICAL CULTURAL ARTEFACTS

- To monitor online trade of stolen or looted cultural artefacts, it is required to identify the same object from different photos by image matching. These photos may have been taken at different angles, viewpoints, lighting conditions, backgrounds, resolutions, etc.
- Most existing image features, including local features such as SIFT and features extracted by pretrained deep learning models, are good at searching for similar objects, but they can not determine whether a found similar object is the same object as the query one.
- The goal of this thesis is to
 - develop or adapt image feature extraction and matching approaches to identify identical objects
 - implement the proposed approach
 - create datasets for training and testing
 - evaluate the developed approach with available datasets

